National Institute of Environmental Health Sciences

A global model study of ozone enhancement during the August 2003 heat wave in Europe

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Abstract:

The European summer of 2003 was characterised by intense heat, prolonged isolation and suppressed ventilation of the boundary layer which, combined with large anthropogenic emissions and strong fires, resulted in a build up of an unprecedentedly high and long-lasting photochemical smog over large parts of the continent. In this work, a global chemistry and transport model GEOS-Chem is compared with surface O3 concentrations observed in 2003 in order to examine the extent to which the model is capable of reproducing such an extreme event. The GEOS-Chem reproduces the temporal variation of O3 at the Jungfraujoch mountain site, Switzerland, including the enhanced concentrations associated with the August 2003 heat wave ($r \leq 0.84$). The spatial distribution of the enhanced surface O3 over Spain, France, Germany and Italy is also captured to some extent ($r \leq 0.63$), although the largest concentrations appear to be located over the Italian Peninsula in the model rather than over Central Europe as suggested by the surface O3 observations. In general, the observed differences between the European averaged O3 concentrations in the summer of 2003 to those in 2004 are larger in the observations than in the model, as the model reproduces relatively well the enhanced levels in 2003 but overestimates those observed in 2004. Preliminary contributions of various sources to the O3 surface concentrations over Europe during the heat wave indicate that anthropogenic emissions from Europe contribute the most to the O3 build up near the surface (40 to 50%, i.e. 30 ppb). The contribution from anthropogenic emissions from the other major source regions of the northern hemisphere, in particular North America, tends to be smaller than those of other years. The model indicates that the large fires that occurred in that year contributed up to 5% (3 ppb) to surface O3 in close proximity to the fire regions and less elsewhere in Europe. Biogenic volatile organic compounds (VOCs) emitted by grass and forest areas contributed up to 10% (5?6 ppb) of surface O3 over France, Germany and northern Italy, which represents a contribution that is twice as large than that found in 2004. These results in terms of contributions from various sources, particularly biogenic emissions, should be seen as preliminary, as the response of vegetation to such extreme events may not be well represented in the model. © CSIRO 2007.

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Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Air Pollution, Temperature

Air Pollution: Ozone

Temperature: Extreme Heat

Geographic Feature: ☑

resource focuses on specific type of geography

None or Unspecified

Geographic Location: ☑

resource focuses on specific location

Non-United States

Non-United States: Europe

Health Impact: ☑

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Model/Methodology: ☑

type of model used or methodology development is a focus of resource

Computing System, Exposure Change Prediction, Methodology

Resource Type: ☑

format or standard characteristic of resource

Research Article

Timescale: ☑

time period studied

Time Scale Unspecified